1881MNRAS..41..325S

are considered, and the Memoir concludes with a statement of the methods which, in the author's opinion, should be adopted in future, for a definitive determination of the solar parallax.

Note on the Durations observed by the French Observers at the Transit of Venus, 1874. By E. J. Stone, Esq.

In the *Comptes Rendus* of the French Academy of Sciences No. 10, March 7, 1881, there is an interesting and valuable paper, by M. V. Puiseux, which contains the results of the contact observations made by the French observers at the Transit of *Venus*, 1874, December 8.

There were eight durations observed by the French observers at five stations: Pekin, Saint Paul, Nagasaki, Saïgon, and Kobé. The observers were Messrs. Fleuriais, Bellanger; Mouchez, Turquet; Janssen, Tisserand; Hérand; and Delacroix. The equations given by M. Puiseux lead at once to the following equations of condition for these eight observed durations:—

1 $x-2{\cdot}94\,.\,\delta\pi = +0''{\cdot}41,$

2 $x-2{\cdot}94\,.\,\delta\pi = +0{\cdot}03,$

3 $x+2{\cdot}85\,.\,\delta\pi = +0{\cdot}61,$

4 $x+2{\cdot}85\,.\,\delta\pi = +0{\cdot}35,$

5 $x-2{\cdot}71\,.\,\delta\pi = -0{\cdot}87,$

6 $x-2{\cdot}71\,.\,\delta\pi = -1{\cdot}11,$

7 $x-1{\cdot}02\,.\,\delta\pi = -0{\cdot}21,$

8 $x-2{\cdot}87\,.\,\delta\pi = +0{\cdot}82.$

In the formation of these equations the mean equatorial solar parallax has been assumed to be equal to $8''{\cdot}86$, and $\delta\pi$ is the correction which that value requires.

The agreement among these equations is not so close as all astronomers must have wished, and most astronomers may have expected, from the care bestowed upon the instrumental equipment of the different expeditions and the skill of the astronomers employed; but except the equations (5) and (6)—of which more hereafter—it may be seriously doubted whether the discordances are not such as must be accepted in such investigations. The error of each equation is the algebraical sum of the errors made at the two contacts.

If we determine the value of $\delta\pi$ from these equations, as they stand, on the assumptions that all the observations are equally good, and that the results are comparable *inter se*, or free from systematic errors, we shall find for the value of the solar parallax

$$8''{\cdot}96 \pm 0''{\cdot}19\epsilon.$$

Here ϵ is the probable error of the difference between a

1881MNRAS..41..325S

distance of the centres of *Venus* and the *Sun*, at contact, and the mean distance between the centres, for all the contacts which are combined in the discussion.

The number of equations combined together is not sufficient for any great reliance to be placed upon the resulting probable error. But with a value of ϵ as large as $0''\cdot5$, or with an assumed probable error of fifteen seconds of time in the observation of the contacts, the theoretical probable error of this result would not exceed $0''\cdot10$; and, unless some of the contacts have been different in kind, such probable errors would be impossible with the optical means at the disposal of the French observers.

The value $8''\cdot96$ is not much larger than that which was obtained from a comparison between the meridian observations of *Mars* made, in 1862, at the Northern Observatories and the Southern Observatories of the Cape and Melbourne; nor is it much larger than the value which will result from a discussion of similar observations made at the same Southern Observatories in 1876. The observations made in 1876 are now under discussion by the authorities at the Washington Observatory, and I had hoped that, long before this time, the result might have been in the hands of astronomers. I have, however, discussed the observations sufficiently to express an opinion that the observations require a value of the solar parallax of about $8''\cdot95$ to satisfy the equations of condition.

I should be prepared to attach very great weight to the value $8''\cdot96$ thus deduced from a discussion of these French durations, were it not clear to me that the equation (5) cannot legitimately be combined in one discussion with the equations (1), (2), (3), (4), (7), and (8), on account of the character of the contact observed at Ingress by M. Janssen.

The following is M. Janssen's account of the contact observed. (*Comptes Rendus de l'Académie des Sciences*, tome lxxx. [1875], p. 344):—

"Dans l'équatorial de huit pouces, dont la lunette est très-bonne, l'image de *Vénus* se montra très-ronde, bien terminée, et la marche relative du disque de la planète, par rapport au disque solaire, s'exécuta géométriquement sans aucune apparence de ligament ni de goutte. Mais il s'écoula un temps assez long entre le moment où le disque de *Vénus* paraissait tangent intérieurement au disque du Soleil, et celui de l'apparition du filet lumineux. Il y a là une anomalie apparente qui, pour moi, tient à la présence de l'atmosphère de la planète. J'ai fait prendre une photographie au moment où le contact paraissait géométrique, et sur cette épreuve le contact n'a pas encore lieu. M. d'Almeida a obtenu une plaque de quarante-sept photographies du bord solaire, qui conduit aux mêmes conclusions. . . .

"Enfin, vers l'instant du second contact intérieur, une éclaircie presque providentielle se produisit sur le Soleil, et nous pûmes, M. Tisserand et moi, prendre l'instant de ce contact, qui fut obtenu avec précision."

1881MNRAS..41..325S

This description of the contact observed by M. Janssen at Ingress should be compared with that given by Admiral Mouchez, *Comptes Rendus*, tome lxxx. (1875), p. 616:—

"Mais, à mesure qu'approchait le deuxième contact, les deux parties extrêmes, plus visibles de l'auréole avoisinant le Soleil, tendaient à se réunir en enveloppant d'une plus vive lumière le segment encore extérieur de la planète, et cette réunion *anticipée* des cornes par un arc de cercle lumineux était rendue plus complète encore par un petit rebord très-brillant de lumière terminant l'auréole sur le disque de Vénus. Prévoyant dès lors qu'il y aurait une très-grande difficulté, sinon une impossibilité absolue, d'observer le contact géométrique, je changeai vivement le verre de couleur bleu pâle pour en prendre un plus foncé, à l'aide duquel j'espérais éteindre cette auréole et ces lueurs accidentelles, mais ce fut inutilement: l'auréole restant toujours visible, je fus obligé de reprendre le verre primitif.

"Dans de semblables conditions, *je dus prendre comme heure du contact, non pas la réunion des deux cornes ou contact géométrique, mais bien le moment où le disque du Soleil ne me parut plus déformé par la lumière brillante qui enveloppait la planète au point de contact.*

"J'ai noté une différence de temps très-sensible entre l'instant où j'ai cru que ce contact pouvait avoir lieu et celui où j'ai acquis la certitude qu'il avait eu lieu.

"Cette observation me paraît donc comporter beaucoup moins d'exactitude que celle des contacts intérieurs du Soleil et de la Lune dans les éclipses totales ou annulaires que j'ai eu l'occasion d'observer. Dans ces éclipses, en effet, il m'a toujours semblé possible de déterminer, avec la précision d'une fraction de seconde, le moment de la rupture ou de la formation de l'anneau. . . .

"Je dois m'empresser d'ajouter que mon collaborateur M. Turquet, avec un excellent équatorial de six pouces, n'a pas vu l'auréole, et qu'il croit avoir obtenu des contacts d'une grande précision."

At the Egress I saw this "aureole" very distinctly, but when attention was concentrated on the contact I lost sight of it, and it did not interfere with my observation of the contact.

It is clear that the time recorded by Janssen for the contact would have been later by "un temps assez long," had he waited until the disturbance of the illumination of the Sun's apparent limb near the point of contact had ceased, and sunlight had reappeared near the point of contact.

And his Ingress-contact cannot, therefore, be combined with such observations of contact as those made by Mouchez, without a correction for the difference of phase observed. The necessity for such a correction of Janssen's time of contact at Ingress was pointed out by me in the *Notices* for 1876, December, before the accurate times of contact had been published, and when, therefore, it was impossible for me to be influenced by any knowledge

1881MNRAS..41..325S

of the value of the solar parallax which would result from a discussion of these observations. The correction clearly required by Janssen's Ingress-contact will make the equation (5) agree more closely with all the other equations except (6), which contains observations made by Tisserand at the same station.

I am unable to find any details of the nature of the contact observed by M. Tisserand. But the residual error of the equation (6) is rather larger than that of the equation (5). It is clearly necessary to reject or correct this equation (5), and I fear, therefore, that it will be necessary also to reject the equation (6). It will be seen that the mean residual error for the equations (1), (2), and (8), with a factor of parallax $-2\cdot9$ is $+0''\cdot42$, whilst the residual error for the equation (6) with a factor of parallax $-2\cdot7$ is $-1''\cdot11$. The residual error of the equation (6), therefore, differs from the mean error of the equations (1), (2), and (8) by no less a quantity than $1''\cdot5$; and from the close agreement of the factors of parallax it is quite impossible to adjust this difference by any change in the adopted value of the solar parallax. Such a difference as $1''\cdot5$ is equivalent to an error of about 45 seconds of time in the observed contacts. It is about equivalent to the whole angular separation between the two phases of the "first appearance of any distinct disturbance of the illumination of the Sun's limb near the point of contact" and the "apparent contact" in a field of considerable brightness; and it would be more than equivalent to such a separation in a feebly-illuminated field where the irradiation would be smaller, and the "apparent contact" at Egress would be earlier and at Ingress later than in a bright field. Speaking from experience, I feel certain that M. Tisserand can never have attempted to observe contacts of the same character as Mouchez. I hope that an examination of the details of his observations will show that he has not attempted to observe at Ingress the "last appearance of any well-marked disturbance of the illumination of the Sun's limb near the point of contact," or at Egress the "first appearance of any such well-marked disturbance," and that it may appear clearly from *a priori* considerations, that his duration cannot be combined with the observations of durations from "real contacts," without a correction for the difference of phase observed.

Rejecting, therefore, on the grounds indicated, (5) and (6), we find from the remaining equations

$$\pi = 8''\cdot88.$$

This appears to be the smallest value of the solar parallax which can be fairly deduced from these observations of duration.

The residual errors of the equations are

$$+0''\cdot15, \quad -0''\cdot22, \quad +0''\cdot25, \quad -0''\cdot02, \quad -0''\cdot50, \quad +0''\cdot56.$$